

Photoemission Electron Microscopy in Energy Research: Current Status and Perspectives

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The ongoing miniaturization of technological devices and progress in surface science demand novel, powerful *microscopy* methods for material characterization on a length scale of only a few atomic distances. One such method is photoelectron emission microscopy (PEEM) which allows for direct imaging of the chemical, magnetic and electronic band structure with spatial resolution of ~ 10 nm. The full-field mode of operation allows for rapid acquisition of images, while variable photon energies can largely overcome the exclusive surface sensitivity of tunneling microscopy techniques. Furthermore PEEM performed with synchrotron radiation (XPEEM) provides electronic and chemical analysis with an energy resolution of ~ 200 meV making XPEEM a powerful technique for *in situ* real-time, full-field imaging and spectroscopic investigation of surfaces. By combining XPEEM with low-energy electron microscopy (LEEM), structural sensitivity and diffraction techniques are added to spectroscopy, enabling a powerful multi-technique approach to the study of surfaces on a single system.

The combined XPEEM/LEEM system has great potential to monitor dynamic surface processes, for example in catalytically relevant chemical reactions on surfaces. Whereas currently the time resolution of PEEM using core level photoelectrons is limited to few seconds per frame, LEEM can image at video rates. LEEM is therefore crucial in following directly dynamic phenomena, such as adatom diffusion and propagation of chemical waves. Moreover, the high brilliance of NSLS-II, combined with much improved transmission in the state-of-the art aberration corrected XPEEM/LEEM systems, would reduce the acquisition time in the XPEEM to hundreds, or possibly tens of milliseconds, allowing for the observation of both, space and time characteristics of reaction wavefronts. These faster acquisition times will probably allow minimizing radiation damage and sample charging, opening the way to the investigation of several oxide systems that are now "off-limits" to standard XPEEM/LEEM systems.

In this talk I will present current status and future perspectives of application of XPEEM/LEEM to studying electronic, chemical and structural properties of the functional components of materials for energy related research.